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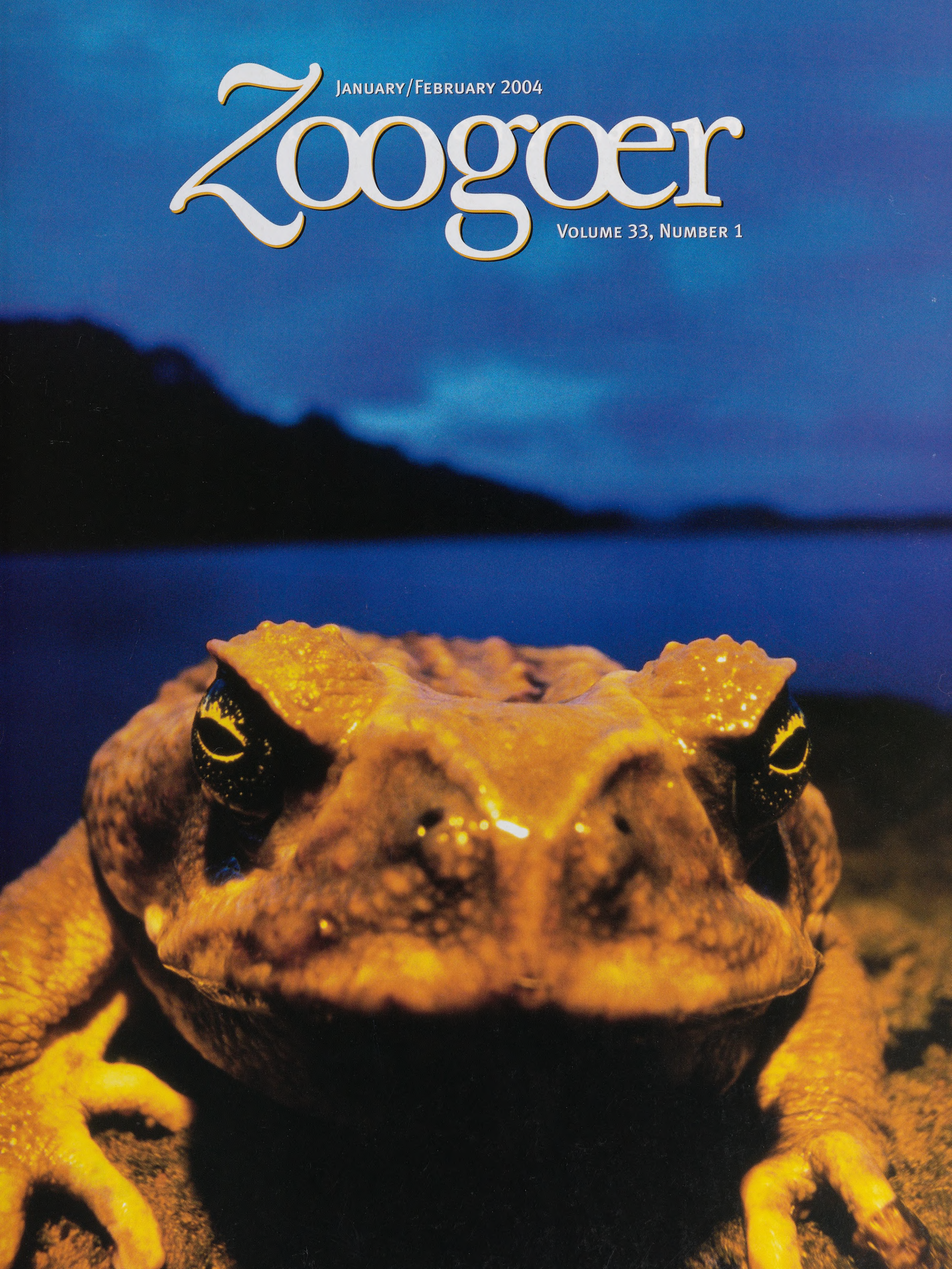

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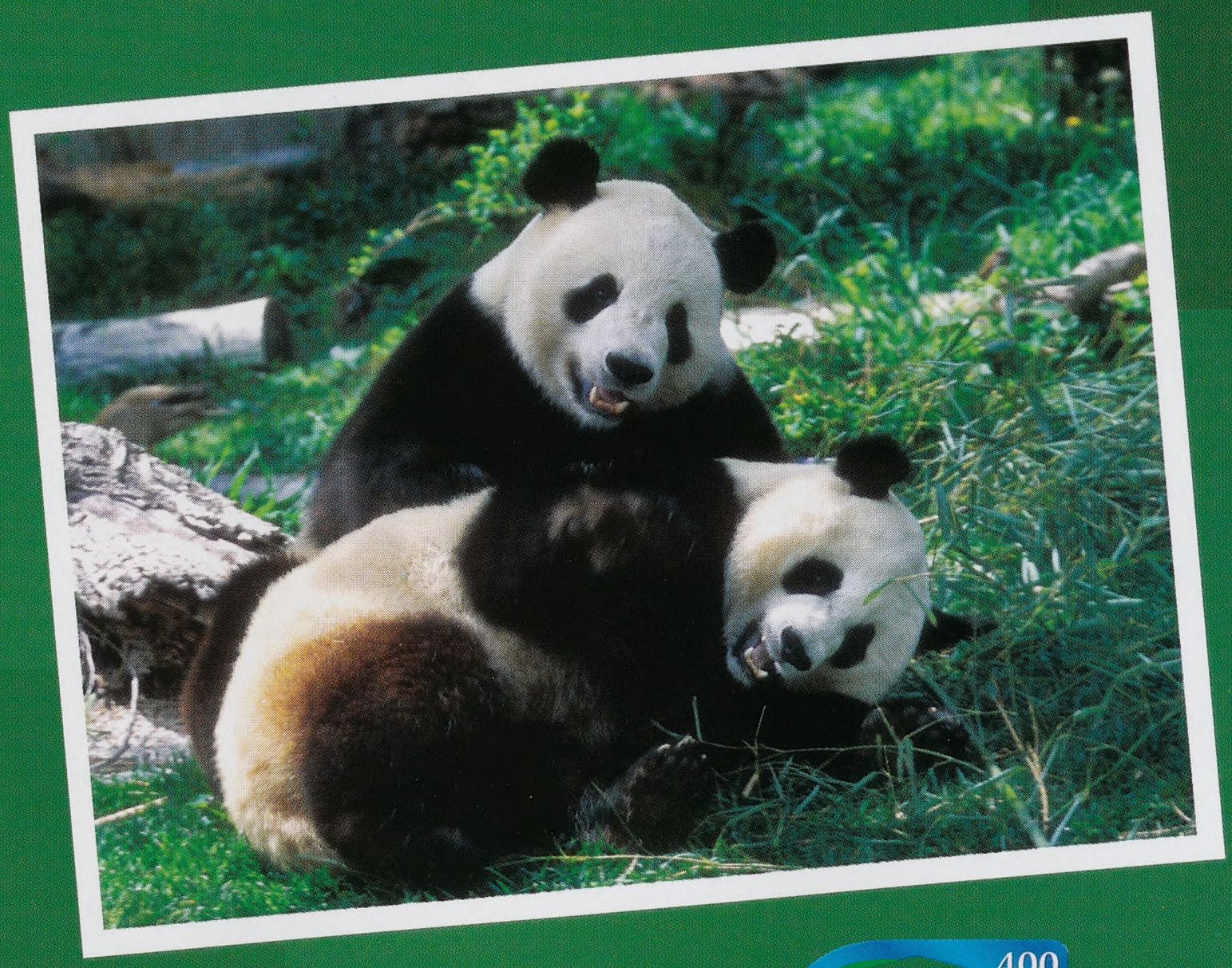

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Among the best recognized, but rarest animals in the world, giant pandas have come to symbolize endangered species and international conservation efforts. In an effort to help protect the giant pandas and secure their future, Fujifilm is proud to be the lead corporate sponsor of the Zoo's giant panda program.

Fujifilm's support helped the National Zoo bring giant pandas Mei Xiang and Tian Tian to Washington, and is assisting the Zoo's experts to develop the scientific knowledge they need to ensure the survival of pandas in the wild. Fujifilm also supports comprehensive conservation education programs designed to help children and adults learn more about giant pandas and the conservation of all wildlife and their habitats.

Friends of the National Zoo

Smithsonian
National Zoological Park

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FONZ FORUM

NEW LEADERSHIP AND A STATEMENT FROM THE FONZ BOARD

I am pleased to report that Thomas D. LaRock has been named to the position of executive director of FONZ. Mr. LaRock has more than 20 years of experience in the zoological park profession, most recently as senior vice president for government relations and external affairs at Zoo Atlanta in Georgia.

In making the announcement, FONZ President Mark Handwerger said, "Tom brings us a wealth of experience that runs the gamut from development and marketing to human resources and concessions management. He also truly loves animals and zoos. I believe he will be an outstanding leader of our organization and a real asset to the National Zoo."

Tom began his career in zoos in 1982, when he became the Toledo Zoological Society's development and marketing director. He subsequently served as executive director of the Alabama Zoological Society; executive director of the Seneca Zoological Society in Rochester, New York; and corporate vice president for human resources and administration at Zoo Atlanta. Tom has also operated a business offering specialty natural history tours for zoos, natural history museums, and conservation organizations. He is a professional fellow of the American Zoo and Aquarium Association.

Tom, who has followed the progress of FONZ and been a frequent National Zoo visitor since the early 1980s, told me, "I am delighted to accept this challenging and coveted position in the nation's capital. FONZ and the National Zoo are leaders in the zoo field and the opportunity to lead a leader is a great honor. I look forward to getting started." Mr. LaRock's first day on the job will be in early January.

Tom succeeds Clinton A. Fields, who retired in September after serving as FONZ's executive director for 15 years. I will continue to serve as deputy executive director of FONZ.

I would also like to share with you the FONZ Board of Directors' statement on animal care at the National Zoo, issued by President Handwerger in the wake of articles in the media criticizing care at the Zoo. It is as follows:

"Friends of the National Zoo was born in 1958 out of the need to revitalize the National Zoo, and we continue to support the Zoo as it addresses concerns about animal care raised in recent media reports. We, as an organization, do not have the expertise to oversee the Zoo's animal care or review its policies and procedures. However, if there is evidence that animals were being mistreated, or if less than adequate care was being provided, FONZ would expect appropriate action to be taken. As people who care deeply about animals and believe in the mission of the Zoo, we could not and would not do less.

We feel confident that the National Academy of Sciences review requested by Congress will strengthen oversight of the National Zoo and further ensure that 'our nation's zoo' provides the best in animal care. The FONZ Board looks forward to the Academy's report and will assist the Zoo in adopting its recommendations in any way we can. We are confident that our members will continue their outstanding support of these efforts as well."

I, too, feel confident that your participation in and support of our nation's Zoo will be stronger than ever as the Zoo program of renewal and revitalization continues on the path of restoring our world-class status. I also look forward to Tom LaRock's leadership enabling FONZ to assist the Zoo in achieving that goal.

Sincerely,

James M. Schroeder
Acting Executive Director

Friends of the National Zoo is a non-profit organization dedicated to supporting the conservation, education, and research efforts of the Smithsonian's National Zoo. Formed in 1958, FONZ was one of the first conservation organizations in the nation's capital. Friends of the National Zoo is dedicated to supporting the Smithsonian's National Zoo in a joint mission to study, celebrate, and protect the diversity of animals and their habitats.

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Smithsonian ***National Zoological Park*** is located at 3001 Connecticut Ave., N.W., Washington, DC 20008-2537. Weather permitting, the Zoo is open every day except December 25. Hours: From May 1 to September 15, grounds are open from 6 a.m. to 8 p.m.; buildings, 10 a.m. to 6 p.m. From September 16 to April 30, grounds are open from 6 a.m. to 6 p.m.; buildings, 10 a.m. to 4:30 p.m.

Membership in FONZ offers many benefits: programs, publications, discounts on shopping and events, free parking, and invitations to special programs and activities to make zoogoing more enjoyable and educational. To join, write FONZ Membership, National Zoological Park, Washington, DC 20008, call 202.673.4961, or go to www.fonz.org.

Membership categories and annual tax-deductible dues are:

Family (includes children 3-16 years)	$49
Double	$44
Individual	$39
Senior Citizen (individual or couple)	$28
Contributing	$75
Sustaining	$150
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Director's Circle	$2500
ZooGoer (for those outside a 200-mile radius of Washington, DC)	$25

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Visit FONZ's website at: www.fonz.org

Cover photo: A male marine toad (*Bufo marinus*) emerges from Gatun Lake, Panama, onto the shore of Barro Colorado Island. Christian Ziegler

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AZA Accredited — The Smithsonian's National Zoo is accredited by the American Zoo and Aquarium Association.

LETTER FROM THE ZOO DIRECTOR

RESPONSE TO MEDIA REPORTS

The last several days have been very difficult for the entire community of Zoo staff and supporters, and for me personally. I appreciate your continued support in the face of criticism of the Zoo, some of our staff, and me.

I want to address some of the items the news media have not reported. *The Washington Post* focused on 23 difficult veterinary cases that occurred from 1998 to 2003, during which time Zoo staff provided care for 2,500 to 3,000 animals each day. Most of those animals lived long and healthy lives. Also during that period, the Zoo's veterinary staff examined and treated more than 4,000 animals and entered more than 14,000 medical records into a database.

Animal care is a team effort among veterinarians, pathologists, keepers, curators, nutritionists, and facilities managers. Currently we have three board-certified zoo veterinarians who practice clinical medicine, as well as two more who are preparing to take the board-certifying exam. The newspaper primarily used one former Zoo pathologist's perspective as its measuring stick for determining which of the 23 cases were caused by "human mistakes."

The perspective of a pathologist is one of hindsight. By contrast, vets often try to solve complex medical problems with incomplete information. Medicine is a puzzle. The goal is to find all the pieces of the puzzle—a challenge in any species—and the pathology report often provides the missing pieces needed to put the whole case together. When an animal dies the animal care team learns from the necropsy performed by the pathologist, and we incorporate this knowledge into our animal-care procedures.

There are other challenges unique to zoo medicine. In veterinary medicine, your patient is a wild animal that cannot tell you what the problem is. Because our veterinarians cannot easily put a stethoscope on or get a blood sample from most of their patients, they must first make a difficult decision whether or not to capture or anesthetize the animal. So the first step in solving the puzzle is a challenge in and of itself—one that can be stressful and risky to the animal. Another is that zoo veterinary medicine is still a new science—just 50 years old—and new disease patterns or problems emerge over time.

If you pick up the Association of Zoo Veterinarians' publication, for example, you will see that many of the reports center on unanswered questions about diseases or nutritional problems that led to an animal's death. The information gained from the loss of an animal often informs the future care of others of the same species. Yet it often takes a long time before trends appear, and until you have trends, you cannot predict the best methods of diagnosis, treatment, or prevention.

Finally, quality-of-life judgments are made every day for animals that are sick or injured. Zoo veterinarians must balance potential diagnostic procedures with the likelihood of helping the animal.

I also want to address our records and record-keeping system. It was never the intent of anyone at the Zoo to alter clinical records to cover up mistakes. Our animal records are constantly updated and edited for clarity. As new information is gleaned about a case, records are edited to include it sometimes weeks or even months after an initial assessment. We are one of a handful of zoos that maintains a veterinary residency training program in board certification, and oftentimes records written by our vets-in-training need to be corrected.

Our current records system, called MedARKS, is not perfect. It is now being updated as part of an effort by zoos nationwide to modernize animal record keeping, and the National Zoo has been an active participant. In the meantime, we are consulting with other zoos regarding how to best annotate medical records corrections or updates.

In my opening presentation to the National Academy of Sciences panel, I mentioned the need to modernize our records system. We expect that this panel of experts will make recommendations in this area as part of their review of our animal care and management. The panel will provide us with an interim report early in 2004, with its final report due next summer.

Finally, remember that the Zoo today is different from the Zoo three years ago. I am proud of what we have accomplished so far during my tenure as the National Zoo's director.

- We have learned from our mistakes and instituted new policies and procedures that will help us to do a better job of tracking animal health and providing daily care—our top priority.
- Our staff has a passion for the institution, knowledge of its past, and energy to drive the changes needed for the future.
- We have hired new staff who bring added experience in animal care, including three new curators with more than 100 years of combined experience to support and guide the animal care staff. For the first time, we now have four full-time vets on duty.
- We have also hired new staff who bring added experience in zoo administration, including an experienced administrator as deputy director and two bright mid-career scientists. And we will soon hire a new Associate Director for Science.
- We have a new full-time pest control specialist and we are working aggressively to mitigate the rodent population, a bane of zoos everywhere, especially urban ones.
- We have more facilities funding than ever, including funding from Congress for daily repairs, operations, and capital improvements.

To learn more about our progress, please visit our website often, at nationalzoo.si.edu. With your support, we will continue to make the Zoo better than ever. Today's National Zoo is making great strides toward restoring its world-class status. We hope you will judge us by seeing the changes firsthand: a clear winter day is a great time to visit your Zoo.

Lucy H. Spelman
Director
Smithsonian's National Zoological Park

NOTES & NEWS

>>ANIMAL NEWS

A six-month-old male **caracal** (*Caracal caracal*) arrived in October from the Milwaukee County Zoo, to be a companion for the Smithsonian National Zoo's female caracal. Native to African savannas, the Middle East, and southwestern Asia, caracals are small cats characterized by a long, black tuft on each ear. The new male will hold court in his own exhibit for about six months, until he's old enough to be introduced to the female.

A MALE CARACAL ARRIVED IN OCTOBER.

In the Invertebrate Exhibit, **Arizona desert hairy scorpions** (*Hadrurus arizonensis*) mingle with their rainforest-dwelling cousins. When they're side-by-side, you will notice one of the biggest differences between the two species: Rainforest scorpions have large claws that they use to crush prey, while desert scorpions wield smaller claws and stronger venom. Though their stingers rarely harm humans, desert hairy scorpions can take down crickets, other invertebrates, and even baby lizards when they're hungry. At nearly six inches in length, they're the largest scorpions in North America.

Two other newly arrived invertebrates look somewhat similar, but have very different temperaments. **Giant African millipedes** (*Archispirostreptus giga*) and **Arizona giant centipedes** (*Scolopendra subspinipes*) both have long, segmented bodies and many legs. But that's where the similarity ends. The millipedes are gentle herbivores, eating decaying vegetable matter on rainforest floors. The centipedes, however, are vicious predators that will clamp their poisonous jaws down on insects, worms, and slugs. The bite of an Arizona giant centipede causes painful sores in people and pets.

For the Zoo's new **patent leather beetles** (*Odontotaenius disjunctus*), named for their shiny black shells, decaying wood is always the meal du jour. The beetles prefer to dine on stumps and logs of deciduous trees, and dig extensive tunnels—or galleries—into the wood, where they live in colonies, mate, and raise larvae. Adults can make clicking and squeaking noises by rubbing their wings along their abdomens.

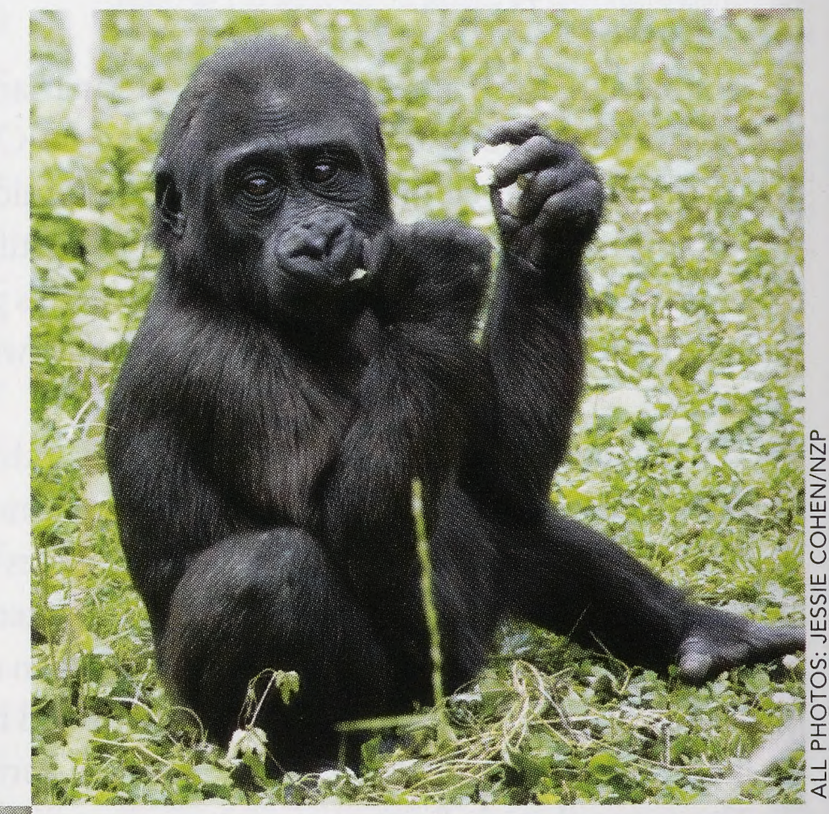
PATENT LEATHER BEETLES.

ARIZONA DESERT HAIRY SCORPION.

Though best known for their nasty bite, which kills cells and often leaves a scar, **brown recluse spiders** (*Loxosceles reclusa*) are actually shy, non-aggressive spiders that will bite humans only if trapped or provoked. Zoo keepers feed the spiders crickets to mimic their natural insectivorous diet.

Armchair zoogoers can make a virtual visit to the Zoo's western lowland gorilla exhibit with the debut of a new **gorilla web cam** this winter. From your home computer, you can watch the Zoo's nine western lowland gorillas (*Gorilla gorilla gorilla*) when they're outdoors. You might catch playful youngsters Ktembe, Kwame, and Kojo chasing each other around their exhibit, or glimpse Kuja beating his chest in a dominance display directed toward Baraka.

The gorilla cam is one of several animal cams scattered throughout the Zoo. Currently, animal cams feature gharials, Asian elephants, naked mole rats, and giant pandas, among others. Visit nationalzoo.si.edu/animals/webcams online to see the animals in action.



KOJO HAMS IT UP ON THE GORILLA CAM.

ALL PHOTOS: JESSIE COHEN/NZP

>>FONZ LEADERSHIP IN 2004

FONZ is pleased to welcome Tom LaRock as our new executive director. Tom was the senior vice president of government relations and external affairs at Zoo Atlanta.

On the FONZ Board of Directors, Deborah Knuckey will serve her first term, and she is our only new member this year. Six people were elected to serve second terms on the Board: Thomas Arundel, Chris Capuano, James Hinchman, Sue Ruff, Grace Toh, and Eric Weiss; and Bernard K. Jarvis and Missy Kelly were elected to serve third terms. Mark Handwerger was elected to serve his third term on the Board, and members of the Board have selected Mark to serve as our President. Replacing Mark as First Vice President is Jim Hotvedt, while other officers remain the same. Jeff Lande is Second Vice President, Grace Toh is Treasurer, and Nicole Chestang is Secretary.

>>URBAN NATURE TRAIL

The Zoo is chock-full of exotic animals from faraway lands, but there's a world of amazing wildlife just outside the exhibits and in your own backyard. The Zoo's Urban Nature Trail will open your eyes to the abundant flora and fauna that thrive in the Washington, D.C., metropolitan area. Through a series of signs, hands-on programs, and interpretive exhibits at the Zoo, the trail will teach visitors how people and wildlife affect each other, and will encourage visitors to conserve local ecosystems.

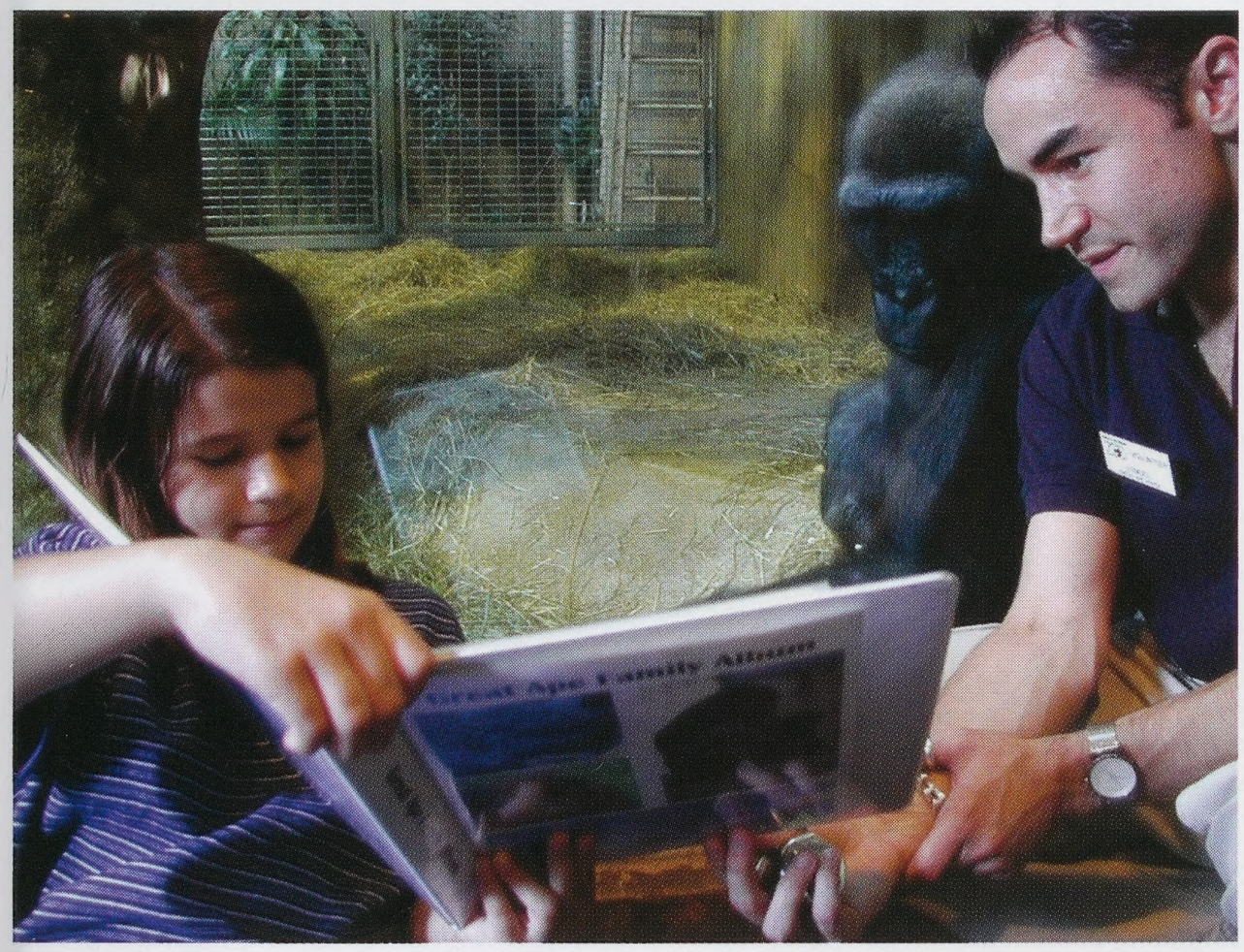
The first stage of the trail, an outdoor classroom located across from the Cheetah Conservation Station, was completed in December 2002. The classroom's teaching stage is made of recycled tire material, and the seating area is surrounded by native plants that feed and shelter local animals throughout the year. Here, visitors of all ages, including schoolchildren, will learn about local natural history.

The first Urban Nature Trail interpretive station, located next to the Butterfly Garden and across from the Invertebrate Exhibit, was completed this fall. This Rotting Log station focuses on the role of decaying wood as habitat for local plant and animal species. In the future, the Urban Nature Trail may also include stations to teach visitors how to create a wildlife-friendly backyard, protect box turtles and local bats, and compost their yard and garden waste.

To learn more about the wildlife in the Zoo's backyard, visit nationalzoo.si.edu/animals/backyardbiology online.

JESSIE COHEN/NZP

LOOK FOR WILDLIFE IN THE ZOO'S BACKYARD.



LEMUEL ODELL IS A VOLUNTEER EXHIBIT INTERPRETER AT THE GREAT APE HOUSE.

>>VOLUNTEER CORNER

FONZ wishes to thank the 1,778 volunteers who contributed a total of 88,016 hours in support of the National Zoo in 2003. Check out these great volunteer opportunities to see if one may be right for you.

If you like to work behind-the-scenes, consider becoming a Zoo support volunteer. Behavior Watch participants collect thousands of hours of vital data on a wide variety of species, and explain their findings to Zoo visitors. Keeper aides help the animal care staff clean enclosures, prepare food, and complete special projects. Horticulture volunteers tend gardens throughout the Zoo and in its greenhouse, and Zoo Help volunteers fill many needs, such as assisting office personnel and painting.

If you're outgoing, join the education volunteers, who interacted with more than 1.2 million visitors in 2003. Exhibit interpreters share their knowledge of the natural history, care, and conservation of a particular group of animals with Zoo visitors, and lead activities at special events. Guides conduct tours throughout the grounds and act as interpreters in the Zoo's outdoor areas. "How Do You Zoo?" volunteers work in an interactive model of some of the Zoo's offices, overseeing children who are role-playing Zoo careers. Outreach volunteers explain the mission and activities of FONZ and answer questions to potential members, and Zoo on Wheels volunteers take animal-related objects, such as posters, slides, and videos—but not live animals—to audiences unable to come to the Zoo, specifically seniors in day-care centers and children in hospitals.

Maybe you're a party animal—if so, Special Events is where you belong. These volunteers make possible exciting Zoo events such as ZooFari and the North American Wildlife Celebration, especially during the spring and fall. Duties vary widely and might include setting up before an event, assisting with arts and crafts, or dressing up as a panda and passing out pins.

Teen volunteers work primarily during the summer months, though some positions are available year round. They lead groups through the "How Do You Zoo?" exhibit, assist FONZ teachers at Summer Safari day camp, help the Zoo's horticulture department, and act as exhibit greeters in several animal houses.

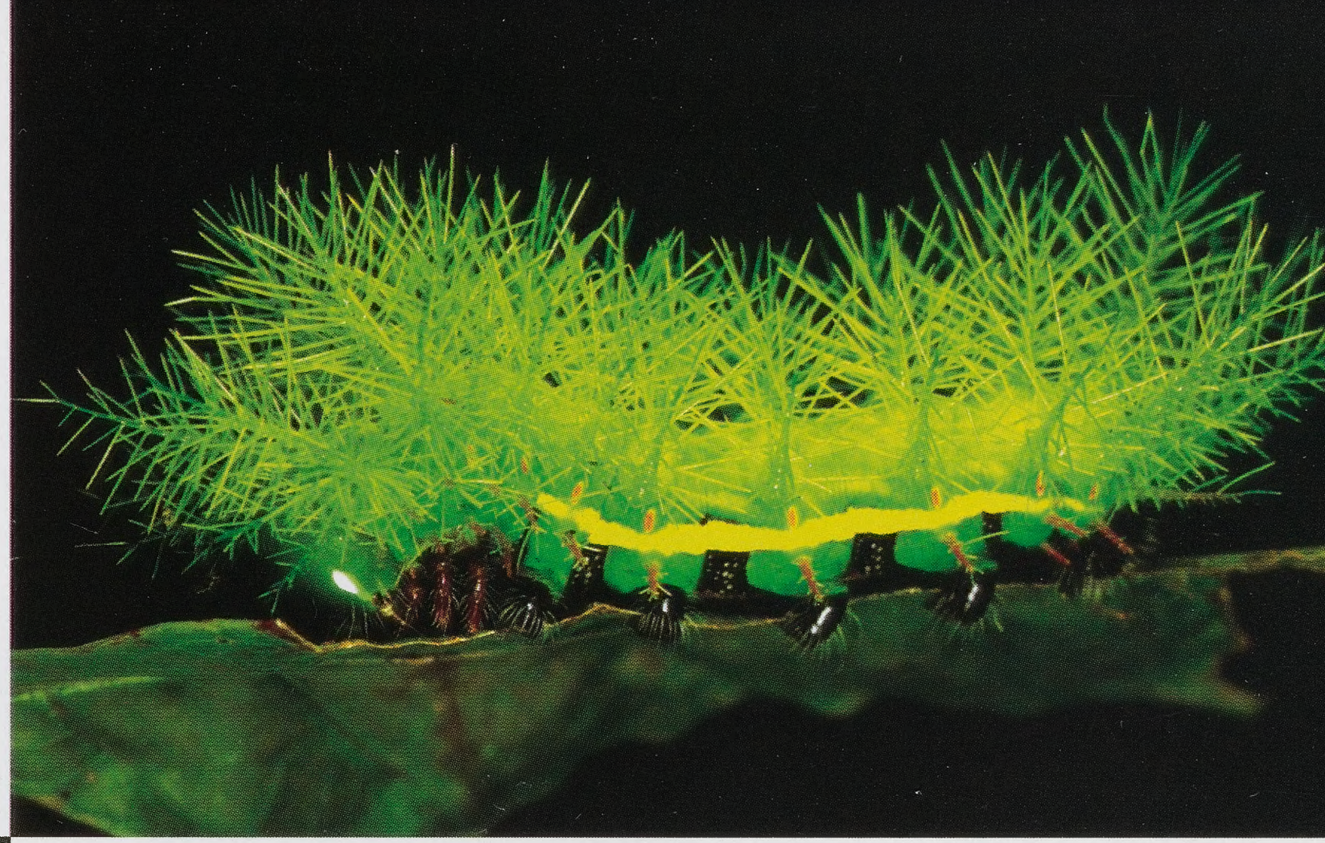
Groups also come to the Zoo to help us with one-time projects. Corporations, alumni groups, schools, and other organizations help make the Zoo grounds beautiful and participate in special events.

If you would like to learn more about volunteering please visit our website at nationalzoo.si.edu/support/volunteer/default.cfm, or call 202.673.4956.

LIFTI

BELOW: A RED-EYED TREE FROG (*AGALYCHNIS CALLIDRYAS*) USES ITS SPECIALLY DEVELOPED TOE PADS LIKE SUCTION CUPS TO CLING TO A BROMELIAD.

RIGHT: POISONOUS SPINES WARN PREDATORS TO LEAVE THIS CATERPILLAR, OF THE MOTH FAMILY LIMACODIDAE, ALONE.



N C EEN VEIL

STORY AND PHOTOS BY CHRISTIAN ZIEGLER

Rainforests are fantastic places, so full of magic they seem unreal. Life is everywhere, overwhelming us with the colors, shapes, sounds, and smells of exuberant nature. Rainforests are also very subtle places. Many animals are quiet and hide from visitors. It takes a long time to become aware of even a few of the countless creatures you are walking among. But if you close your eyes, you can feel their vibrant, if elusive, presence.

THE DIVERSITY OF FLORA ON BARRO COLORADO IS EVIDENT IN THIS COLORFUL ARRAY OF SEEDS AND NUTS FROM NEARLY 30 PLANT SPECIES.

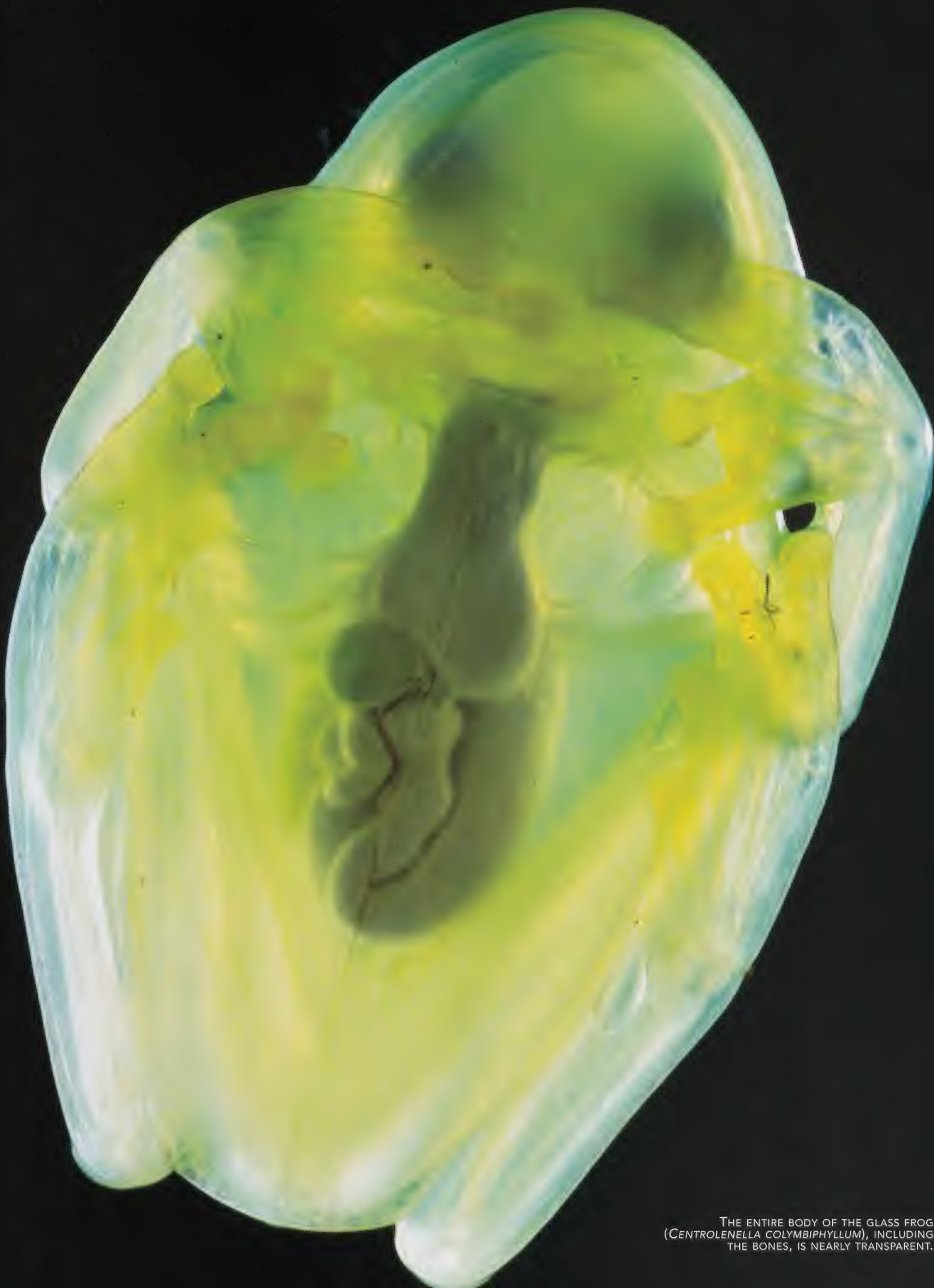
A COATI (*NASUA NARICA*) EATS THE CONTENTS OF A CROCODILE EGG.

The forest excels at concealing its treasures, challenging, and sometimes frustrating, a photographer like me. There may be a rustling in the leaf litter, the buzzing of an insect, a snake slithering into the ocean of green, a faint sweet smell hinting of a flush of flowers 100 feet above. You often perceive these events too late to get even a glimpse of the mysterious creatures responsible for them; they may be too high up in the leafy canopy, or too well camouflaged from sight. But then, in rare single moments, magic happens. A bird flits by and comes to rest, the sun shines on just the right spot to illuminate it, and you can see it or even snap a photo or two before the scene starts to fall apart again. The forest opens its windows only briefly and rarely to share a secret with an observer.

I've looked through these windows to photograph the rainforest of Barro Colorado Island for *A Magic Web: The Forest of Barro Colorado Island.* In a former life, Barro Colorado Island (BCI) was the top of a large hill in central Panama. Then, during the construction of the Panama Canal between 1911 and 1914, the Chagres River was dammed. Rising waters crept up the hill, leaving the hilltop isolated to form the largest island in the artificial body of water now known as Lake Gatun.

Covered with lush rainforest, the island has been studied and protected since the 1920s. In 1923, BCI was designated a sanctuary for the study of the tropical nature of the Canal Zone, becoming one of the first biological reserves in the New World. Since then, BCI has emerged as the most intensively studied area in the tropics of the Americas and, indeed, of the world. In 1946, the Smithsonian Institution assumed the management of Barro Colorado and it became the seed from which the Smithsonian Tropical Research Institute (STRI) would develop, beginning in 1966. Today, BCI remains STRI's main

A BROAD-BILLED MOTMOT (*ELECTRON PLATYRHYNCHUM*) APPROACHES ITS NESTING TUNNEL, WHICH IS BUILT ON A STEEP SLOPE TO KEEP PREDATORS AT BAY.



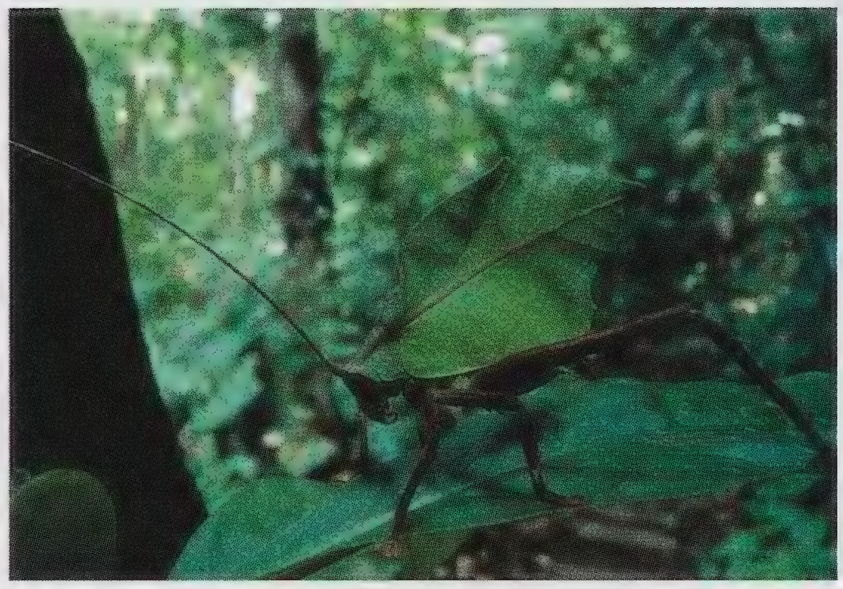
THE ENTIRE BODY OF THE GLASS FROG (*CENTROLENELLA COLYMBIPHYLLUM*), INCLUDING THE BONES, IS NEARLY TRANSPARENT.

research station. A small campus in the rainforest, the station boasts housing for up to 60 scientists, modern lab facilities, and high-speed Internet. These amenities and a lively intellectual atmosphere attract scientists from around the globe, making the island a mecca for tropical ecologists.

Positioned at the crossroads of two continents and two oceans, Barro Colorado is home to stunning biological diversity: 1,316 plant species, 381 bird species, and 102 mammal species have been recorded, while the number of insects is so great that it remains unknown. These thousands and thousands of different organisms, unique forms of life on Earth, each play a role in a vivid and complex web that makes the forest ecosystem function as a whole. But most of the living activity in the web goes on secretly and quietly, hidden behind a thick green curtain of vegetation or concealed by its miniature scale.

A microcosm of the web can be found in each square meter of forest leaf litter, where tens of thousands of springtails and mites feed on decaying plant matter and the fungi that grow on it, and vicious predators—large spiders or centipedes and sometimes more then a dozen species of ants—in turn feed on the arthropods. Seemingly small in scope, this so-called brown food web is essential for the cycling of nutrients in a tropical rainforest.

At a more human-size scale, mammals and other larger creatures play out their various roles as predator or prey or both. Ocelots eat sloths, for instance, and sloths eat leaves. To a plant, an animal may be a predator, and BCI is rich in leaf, seed, and fruit eaters. A bat called *Artibeus jamaicensis*, or the fruit vampire, is the most common bat species on BCI and loves fig fruits. But this is one of 20 bat species that dotes on fig fruits, which are available year round, and each likely has its own way to take advantage of them. Larger bats eat larger fruits, for instance. Such a diverse set of fruit-eaters—and there are other species that feast on figs as well—is not possible in a temperate zone, where fruit is seasonally available, accounting in part for the tropics' greater species diversity.



A WALKING STICK INSECT OF THE ORDER PHASMATODEA RESEMBLES ITS LEAFY PERCH, RENDERING IT NEARLY INVISIBLE TO A PASSERBY.

TOM & PAT LEESON

With diverse and abundant predators, prey have evolved amazing defenses. Katydids in the genus *Mimetica*—for mimic—exhibit near-perfect camouflage. Their color, shape, and texture imitate the leaves they rest on with incredible precision. But katydids are not just concealment artists. Some of them are specialized herbivores that prey on a single species or genus of plants. Specialized herbivorous insects help maintain tree diversity by preventing any given plant species from reaching high densities. On the other hand, the wide dispersion of the members of the tree species helps trees to hide from their specialized predators.

For every animal and plant I meet, I know that many other species—it might be dozens, hundreds, or even thousands—stay hidden. Each has a story to tell, sometimes bizarre and almost unbelievable, always interesting and fascinating, waiting for us to listen to it.

My goal as a photographer was to lift the green curtain of Barro Colorado for brief moments, to reveal the layers of the forest, to unravel its complex ecology, and to convey its beauty. This unparalleled habitat deserves our attention and protection. Z

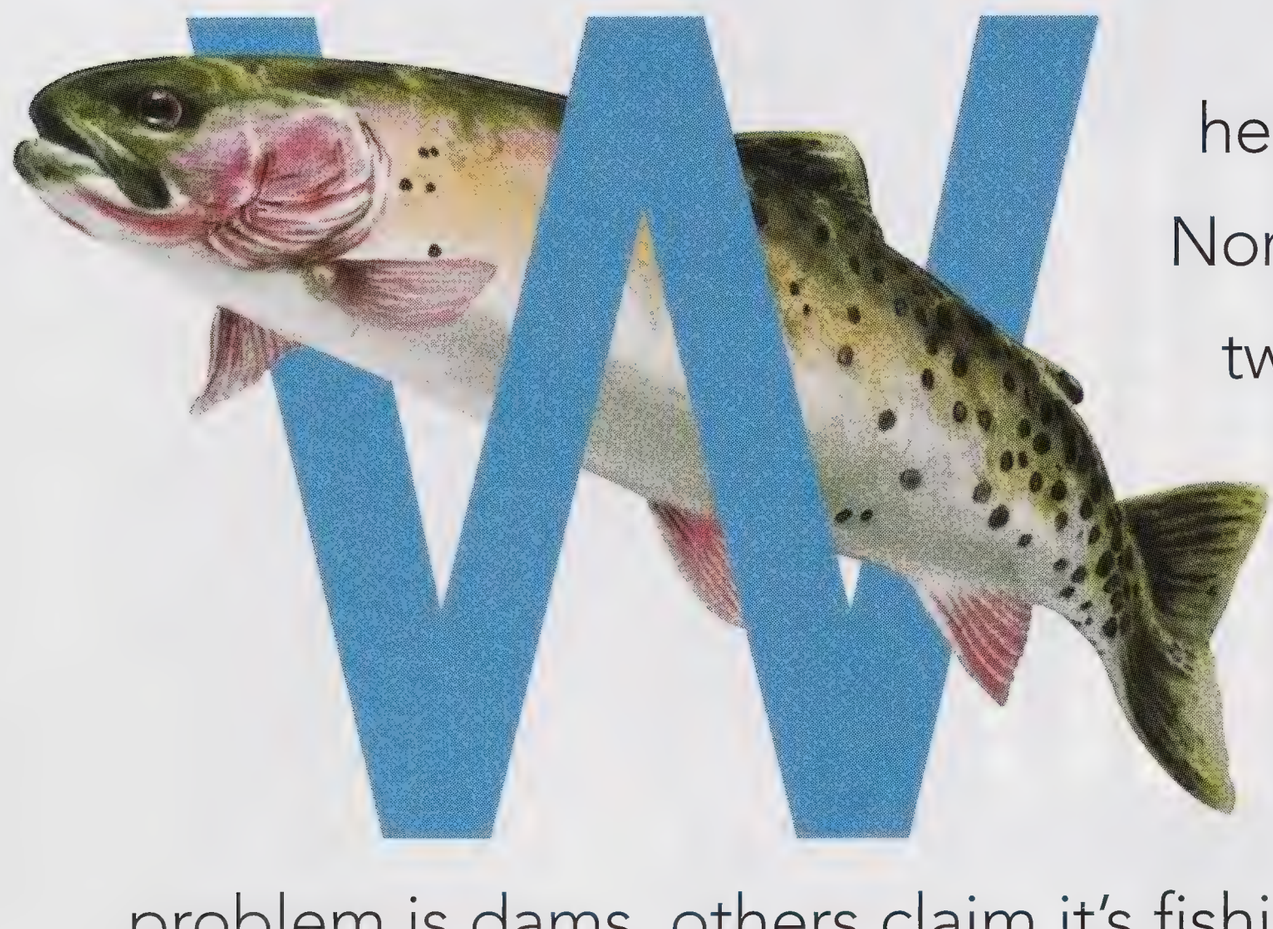
—A Magic Web: The Tropical Forest of Barro Colorado Island, *by Christian Ziegler and Egbert Giles Leigh (ISBN 0195143280), was published by Oxford University Press in 2002. Visit the website at www.amagicweb.com.*

SHOWY ORANGE FUNGI (*XEROMPHALINA* SP.) DECOMPOSE ROTTING VEGETABLE MATTER AND CYCLE NUTRIENTS BACK INTO BARRO COLORADO'S SOIL.

A male coho negotiates a shallow part of a spawning stream in the Pacific Northwest.

STRUGGLING AGAINST THE CURRENT

BY ROBIN MEADOWS



When it comes to wild salmon in the Pacific Northwest, people generally agree on only two things: These fish are in trouble, and it's important to save them. After that, the conversation degenerates into a debate over the cause of salmon decline. Some insist the biggest problem is dams, others claim it's fishing, and still others say it's habitat loss. The salmon have no say, they just keep sliding toward extinction.

ILLUSTRATION: ROBERT W. HINES/USFWS, PHOTO: TOM & PAT LEESON

The disappearance of salmon from the Columbia River, which flows between Washington and Oregon, is not up for debate. The Columbia was once one of the greatest salmon rivers in the world. Historical runs were enormous, with roughly 15 million adult salmon returning to spawn each year. But throughout the last century, wild salmon have dwindled there, and today's runs are only a tenth of what they once were.

The Columbia's salmon slump echoes a larger problem throughout the North Pacific. "Most of the wild stocks...have declined to very low levels and many are in clear danger of extinction," says Daniel Goodman, Director of Environmental Statistics at Montana State University in Bozeman.

Another indisputable fact: Many factors are harming wild salmon. These include dams, fishing, habitat loss and degradation, and production of hatchery salmon that compete with their wild cousins for food. However, interest groups downplay each of these factors and point their finger at others to take responsibility for the salmon's decline, and for their salvation. "Wild salmon recovery in western Washington is a biologically simple but politically difficult task," says Billy Franks, chairman of the Northwest Indian Fisheries Commission, in a *Seattle Daily Journal* commentary.

Sorting out the politics of wild salmon recovery in the North Pacific is tricky because one important thing is not clear. No one really knows how much each factor contributes to the salmon's imminent demise, says Goodman. But we do know that salmon have far-reaching ecological impacts, which means that if we lose them, we will lose a lot more than just the fish themselves.

WILLIAM MULLINS

MOST SALMON DIE AFTER SPAWNING, AND THEIR CARCASSES RETURN NUTRIENTS TO THE LAND.

ECOLOGICAL IMPORTANCE OF SALMON

The term Pacific salmon generally refers to seven species in the family Salmonidae: chinook, chum, coho, pink, and sockeye salmon, and cutthroat and steelhead trout. They range from pink salmon, which average three to five pounds, to chinook, which average 10 to 15 pounds but can get much bigger—up to 135 pounds, according to the Washington Department of Fish and Wildlife.

The basic life cycle of salmon starts when they hatch from eggs laid in streams and rivers. The young begin growing in fresh water and estuaries, finish growing in the ocean, and finally migrate back to their birth sites to spawn and start the whole cycle over again. This cycle differs slightly within each species and among populations because salmon habitat is vast and varied, spanning more than 1.5 million square miles of fresh and marine waters. The Columbia Basin alone has more than 1,000 miles of rivers, and extends from the mouth of the Columbia River to its headwaters in Washington, Oregon, and Idaho, and even into parts of Montana and Canada.

BLACK BEARS AND GRIZZLIES IN THE PACIFIC NORTHWEST DEPEND ON ANNUAL MIGRATIONS OF SPAWNING SALMON.

Because Pacific salmon live in a tremendous variety of habitats, there are hundreds of different populations, or stocks. Even if two stocks are the same species, one cannot be substituted for another because each has adapted its own niche. Some stocks, for example, spawn near the Columbia's mouth and overwinter in the sea. Other stocks spawn in tiny streams in mountain headwaters and spend their first winter in fresh water.

Many Pacific salmon stocks are already extinct, and 26 are federally listed as threatened or endangered. The issue goes beyond saving the salmon themselves, because the fish play a "crucial role in supporting overall ecosystem health," according to John Cederholm and his colleagues in a 2000 Washington Department of Fish and Wildlife report titled *Pacific Salmon and Wildlife—Ecological Contexts, Relationships and Implications for Management.*

TOM & PAT LEESON

BALD EAGLE NUMBERS NEAR GLACIER NATIONAL PARK'S MCDONALD CREEK DROPPED BY 96 PERCENT WHEN SALMON BECAME SCARCE THERE IN THE LATE 1980S.

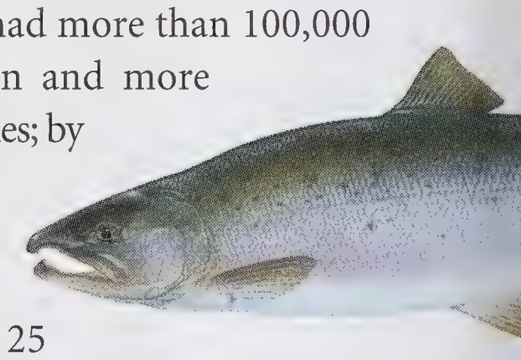
Salmon are vital to the Pacific Northwest's ecosystems; they are a major source of nutrients for many animals, and also for some plants. When migrating salmon drift ashore or are eaten by animals, they cycle back into the land nitrogen, phosphorous, and other nutrients that are continually washing out of the land and into the ocean. Salmon directly link ecosystems that are half a world apart, all the way from their inland spawning grounds to their ocean feeding grounds, which extend north of the Aleutian Islands and to the Asian side of the Pacific.

TODAY, WILD PACIFIC SALMON RUNS ARE SO DIMINISHED THAT THEY ARE TRANSPORTING ONLY A SMALL FRACTION OF THE NUTRIENTS THEY ONCE BROUGHT BACK TO THE LAND.

Today, wild Pacific salmon runs are so diminished that they are transporting only a small fraction of the nutrients they once brought back to the land. The mass of the salmon now returning to Washington and Oregon rivers has dropped by an estimated 97 percent, from roughly 250,000 to 7,500 tons per year.

This loss of returning salmon affects the many animals that depend on them for food. "[Salmon are] a keystone species to the productivity and biodiversity of the ecosystems of the North Pacific Basin," say Cederholm and his colleagues. Of more than 600 common wildlife species in Washington, 137 are known to depend on salmon in some way. Salmon eggs are eaten by 22 species, including salamanders and common mergansers. Young salmon in fresh water are eaten by 45 species, including osprey and river otters. Salmon in salt water are eaten by 58 species, including Caspian terns and killer whales. Spawning salmon are eaten by 16 species, including harbor seals and black bears. And salmon carcasses are eaten by 83 species, including shrews and grizzly bears. There is an even greater depth to these numbers, because many species eat salmon at more than one stage. For example, grizzly bears eat both salmon carcasses and spawning salmon. Moreover, many species depend on salmon indirectly: American dippers, for example, eat the aquatic insects that live on decaying salmon.

Not surprisingly, ecosystems that lose their salmon can also lose the wildlife that depend on them. For example, after several years of low sockeye salmon returns in Kamchatka's Lake Dalnee, both zooplankton and zooplankton-eating fish decreased substantially (by 30 percent and 45 percent, respectively). Similarly, as salmon declined in Glacier National Park's McDonald Creek, so did bald eagles. In 1981, the creek had more than 100,000 spawning salmon and more than 600 bald eagles; by 1989, the salmon population had collapsed and there were only 25 bald eagles—a 96 percent reduction in less than a decade.



It may come as a surprise, however, that low salmon returns can also affect forest ecosystems. Riparian forests that grow along spawning streams can get a substantial fraction of their nutrients from salmon. In an Alaskan watershed, the leaves of trees and shrubs near spawning streams get about a quarter of their nitrogen from salmon. In the coastal forests of southeast Alaska,

ALL ILLUSTRATIONS: TIMOTHY KNEPP/USFWS

KILLER WHALES ARE ONE OF 58 SPECIES THAT PREY ON SALMON IN SALT WATER.

USFWS

LEFT: SALMON ALEVINS HATCH IN FRESH WATER OR ESTUARIES AND MATURE IN THE OCEAN, RETURNING TO THEIR BIRTH SITES TO SPAWN.

BELOW: AT THE BONNEVILLE FISH HATCHERY, AN EMPLOYEE FILLS TRAYS WITH SALMON EGGS. HATCHERY FISH COMPRISE 90 PERCENT OF THE COLUMBIA BASIN SALMON RUN.

trees near spawning streams grow faster than trees far from spawning streams.

In the most extreme cases, some forests may depend almost entirely on salmon for their nutrients. Siberia's Ussuri River is not a likely place for a forest because it is very cold, gets little sunshine, and has no significant mountains upstream to supply nutrients. Forests grow there nonetheless. Some biologists believe that these forests' main nutrients come from the salmon and other anadromous fish that migrate from the Pacific Ocean to spawn in the Ussuri.

NO EASY FIXES FOR WILD SALMON

Concerns about overfishing salmon in the Columbia date back to the mid-late 1800s, when commercial fisheries hauled in phenomenal catches. Fish wheels scooped up migrating salmon by the millions—a single fish wheel caught 70,000 pounds of salmon in just one day in 1913. Although fish wheels were banned on the Columbia after 1935, the salmon immediately faced an emerging threat: dams. From the early 1930s to 1975, 11 large federal dams were built on the Columbia River for hydropower, flood control, and navigation, with a hazardous side effect on salmon—dams can block migration and keep salmon from reaching spawning streams.

Between fishing, dam construction, and other threats, salmon continued to decline. At the time, the answer to reversing this decline seemed obvious—simply supplement the wild populations with hatchery-raised fish. This approach has been so popular that there are now more than 100 salmon hatcheries in Washington and Oregon. But even though Columbia Basin hatcheries produce 100 to 200 million young salmon each year, wild Pacific salmon are still in trouble.

HATCHERIES

Worse, many conservation biologists believe that hatcheries have done wild salmon more harm than good. Today, hatchery fish comprise 90 percent of the Columbia Basin salmon run. The influx of hatchery fish has kept fishing rates artificially high; consequently, commercial fishers have continued to catch wild salmon even though their populations have been dropping.

Another problem is that hatchery salmon can outcompete wild salmon for territory and food, and will sometimes eat smaller wild salmon. Moreover, fish raised in hatcheries may be adapted to captivity, so they are less suited to natural conditions. For example, hatchery salmon are used to being fed and are not used to avoiding predators. If there is a genetic basis for these behaviors, interbreeding between hatchery salmon and wild stock may make the wild population less suited to natural conditions too.

BOB HEIMS/USACE

Despite all these drawbacks, hatcheries are still releasing salmon in the Columbia Basin. Fishing interests see hatcheries as mitigation for smaller salmon runs. "[Hatcheries] were established to compensate the regional fishing industry for the permanent loss of habitat above dams," says the Pacific Coast Federation of Fishermen's Association. "Hatchery programs in the Columbia are extremely important to maintaining the fishing industry."

Now so-called "conservation hatcheries" have become the trend. The idea is to make hatchery salmon more like wild ones by, for example, building hatcheries that mimic natural conditions, or by using wild-spawned salmon for hatchery broodstock. While some interests champion "conservation hatcheries," so far they are little more than a buzzword. Science has not yet demonstrated whether they will help or hurt wild stocks.

TOM & PAT LEESON

WAYNE BUCHANAN/USACE

IN THE 1920S, NATIVE AMERICANS DIPNETTED SALMON FROM WOODEN PLATFORMS ALONG CELILO FALLS, WHICH WERE INUNDATED WHEN THE DALLES DAM WAS COMPLETED IN 1957.

HABITAT LOSS AND DEGRADATION

Spawning salmon need cold, clear, fast-flowing water, but every year there's less and less of that in the Columbia Basin. Urban development, logging, grazing, and farming can all increase the erosion of silt into streams, which can suffocate salmon eggs. These land uses can also decrease the riparian forests that provide the shade that keeps the streams cold. Warmer waters can kill salmon eggs, and are linked to disease outbreaks and parasite infestations. "[The salmon's] long-term problems are rooted primarily in habitat degradation," says the Northwest Indian Fisheries Commission.

BILL JOHNSON/USACE

THE DALLES DAM AND MOST FEDERAL DAMS ON THE COLUMBIA RIVER HAVE FISH LADDERS TO FACILITATE MIGRATIONS OF SALMON, LAMPREY, AND SHAD.

Not everyone agrees. To take just one example, many farmers in Skagit County, Washington, oppose restoring riparian forest on their property to enhance salmon spawning habitat. "Most farmers argued that agriculture was not the main cause of salmon decline...they believed it was fishing and in particular tribal overfishing," says Sara Jo Breslow in a 2001 EPA report titled *Farmers' Perceptions of Salmon Habitat Restoration Measures: Loss and Contestation.*

Moreover, although biologists say studies show that riparian restoration would benefit salmon, some farmers question the underlying science. They claim that restoring riparian forest would actually degrade salmon spawning habitat because woody debris from the trees would fall into the streams, making them slow down and meander, which in turn would cause more erosion and so increase the sediment in the water. Instead, the farmers suggest other ways to save the salmon, such as paying fishermen not to fish.

THE DAM QUESTION

The Columbia Basin has more than 24 large dams on its main rivers and hundreds of dams on its tributaries. Besides blocking salmon's upstream migration, dams can kill young fish that pass through the turbines on their way to the sea. Dams can also destroy salmon habitat by, for example, creating deep pools that inundate the spawning and rearing grounds. Today, salmon can no longer reach a third of their historical habitat in the Columbia Basin. In addition, the Columbia River has become what amounts to a series of long, narrow reservoirs that provide little spawning or rearing habitat.

GARY SCHULTZ

SOCKEYE SALMON LEAP TO THE TOP OF A FALLS ON THEIR ARDUOUS JOURNEY TO THEIR SPAWNING GROUNDS.

The biggest controversy over dams and Pacific salmon centers on the Snake River, which begins in Idaho and joins the

LEE RENTZ

THESE CHUM SALMON WERE VICTIMS OF FLOODS CAUSED BY CLEARCUTTING UPSTREAM IN SKOKOMISH VALLEY, WASHINGTON.

Columbia River in Washington. While the Snake once produced 40 percent of the Columbia Basin's salmon run, stocks there began declining faster after the construction of large dams in the 1960s and '70s. Today, many of the Snake's wild salmon stocks are extinct or in trouble.

In 2001, more than 200 scientists called for breaching the earthen portions of four federal dams on the lower Snake River. Fishing interests agreed, claiming that the dams account for 90 percent of the fish killed while yielding only small benefits: specifically, that the dams generate only about four percent of the region's hydropower and provide irrigation water for relatively few farms. "There is no question that the hydropower dams themselves have had by far the greatest impact [on Columbia Basin salmon]," says the Pacific Coast Federation of Fishermen's Association.

TO FISH OR NOT TO FISH

But again, not everyone agrees. Save Our Dams founder Tom Flint says the real problem is fishing, not dams. In 1999, Save Our Dams supported an unsuccessful bill that would have banned most commercial salmon fishing in Washington. "For every ten salmon returning to spawn, six are taken by ocean harvest," claims Flint. "Only in the United States can you buy an endangered species for $2 a pound, continue to commercially harvest them, while at the same time spend $1 billion per year to save them." Estimates for how much is spent on salmon recovery efforts vary and Flint's is on the high side, but even so, the cost is undeniably considerable.

Fishing interests counter Flint's claims, asserting that all fishing—commercial, recreational, and tribal—causes only about five percent of human-related salmon deaths. Rather than banning salmon fishing, they advocate "selective harvest" of healthy salmon stocks. The idea is to avoid catching at-risk wild stocks by, for example, timing the fishing seasons or using nets with particular mesh sizes.

However, no one knows if selective harvest will work. In any case, biologists stress that it is critical to make sure that at-risk wild salmon are not caught. "We should stop killing and eating the very salmon that we are trying to save," says the Washington Department of Fish and Wildlife's Cederholm. And for a declining wild stock, any harvest at all is overharvest, points out Montana State University's Goodman.

SPAWNING SALMON NEED COLD, CLEAR, FAST-FLOWING WATER, BUT EVERY YEAR THERE'S LESS AND LESS OF THAT IN THE COLUMBIA BASIN.

SCIENCE AND SALVATION

In the debate over how to save the Columbia Basin's wild salmon, many interest groups support their stance by citing only the science they like, and ignoring the rest. Save Our Dams' Flint, speaking about dam-breaching on the Snake River, says "Dam-breaching is based on voodoo science." The Pacific Coast Federation of Fishermen's Association, which believes hydropower dams have affected Pacific salmon, says "the science is clear, the impacts are clear, the actions we must take are clear." And Sara Jo Breslow, in her 2001 EPA report, notes that "[Farmers] discussed science as if it belonged to particular groups, saying things like 'our science,' 'their science,' or 'the tribes' science.'"

But the biggest problem facing wild Pacific salmon right now may be the fact that the science really isn't clear about who—or what—is to blame, which makes it impossible to move beyond all the finger-pointing. "Just enough is known about these various factors affecting Columbia Basin salmon to raise, alternately, dire suspicions or rosy expectations," says Goodman. "Not enough is known...to define what mix of interventions will be the most efficient at achieving the goal of recovery." In other words, better science may be the wild Pacific salmon's only hope. Z

—Robin Meadows is a contributing editor of ZooGoer.

CARLTON WARD, JR.

TRACKING AN ELEP

I stood frozen at the edge of the muddy clearing, eyeing the big bull elephant cauti
our presence. Lifting my dart gun, I aimed carefully, hoping to hit the bull in his large

A FAMILY OF FOREST ELEPHANTS FORMS A CIRCLE AS IT GRAZES, PLACING ITS YOUNGEST MEMBER IN THE CENTER.

PHANTINE MYSTERY

ously. I knew he would become alarmed if I, or any of the team members, revealed hip muscles, where the anesthesia would be delivered most effectively, and fired.

STEPHEN BLAKE

THIS FEMALE ELEPHANT, NAMED SPIKEY, WAS COLLARED BY SHARON'S AND STEVE'S TEAM IN THE CENTRAL AFRICAN REPUBLIC IN 2001.

The dart was on target, and as if irritated by its sting, the elephant splashed around in the clearing. Minutes seemed like hours as Steve and I anxiously waited to see whether he would run, and in what direction. When he retreated into the trees on the opposite side of the clearing from where we stood, Steve radioed the rest of the darting team, stationed 150 feet back in the forest, to join us. We followed the bull, with pygmy trackers leading the way looking for fresh prints, dung, and disturbed branches. We spotted the anesthetized bull lying comfortably about 200 feet from where I had darted him 15 minutes before.

While I checked the bull's condition and collected skin, blood, and other samples, Steve strapped a telemetry collar around his neck. Finally, we had accomplished part of what we had come to Congo's Nouabalé-Ndoki National Park to do: fit four forest elephants with collars that, through their embedded GPS tracking devices, would enable us to follow the elephants' movements through the central African equatorial forest for the next two years.

This trip, which took place in March and April of 2003, was the third time I'd traveled to the Congo to work with Stephen Blake, a conservationist with the Wildlife Conservation Society (WCS). Steve leads a project to understand the ranging and migration patterns of forest elephants in Africa's equatorial forests, which comprise the largest expanse of rainforest on Earth after the Amazon. The project involves WCS scientists from Congo and Gabon, as well as scientists from the European Union-funded ECOFAC Project, World Wildlife Fund (WWF), Save the Elephants (a Kenya-based charity), and now, with my involvement, the Smithsonian's National Zoo. The WCS Field Veterinary Program, based at the Bronx Zoo, coordinates forest elephant immobilizations for the project.

As one of the project veterinarians, my job is to safely anesthetize elephants so Steve can place telemetry collars on them. In addition, I collect biomaterials (such as blood, feces, ticks, and skin biopsies) that I take back to the laboratory to assess the health of these animals, about which little is currently known. The rest of our team on this trip included a second veterinarian, Robin Radcliffe, from Fossil Rim Wildlife Center in Texas, one Bantu field assistant named Sylvan, and four pygmy trackers, Mossimbo, Adouma, Mambeleme, and Monyaka.

STORY BY SHARON L. DEEM WITH STEPHEN BLAKE

The forest elephant telemetry project began in 1998 thanks to Steve's budding collaboration with the internationally recognized elephant conservationist Iain Douglas-Hamilton, founder and chairman of Save the Elephants. Since the 1960s, Douglas-Hamilton had studied savanna elephant ranging using conventional radiotracking technology, and by the mid-1990s he had developed an impressive satellite telemetry program in East Africa.

Iain was enthusiastic about sharing his knowledge and experience with Steve, and was also keen to expand his operation to the forests of central Africa. He financed two trial collars, which jump-started the program in 1998 after they were deployed under the veterinary supervision of Dr. William Karesh in Dzanga National Park in Central African Republic. Unfortunately, one of the collars failed immediately, and the other only gave GPS data for one month. However, this small data set, in conjunction with a few locations from VHF radiotracking, showed that a female elephant and

her young calf used a home range of at least 340 square miles (880 square kilometers), considerably larger than many had suspected. Not only did she cross the international border repeatedly, but she traveled well outside the boundary of both Dzanga-Sangha Reserve and Nouabalé-Ndoki National Park.

This was a tantalizing look into the almost unknown world of forest elephant movements. But the disappointing collar performance stalled the project for the next two years, while collar technology improved. When Iain had successfully tested a new generation of collars on savanna elephants, STE funded four new collars for the forest program in late 2000, and Steve and his colleagues were ready to try again. Luckily for me (and, it turns out, for Steve who is now my husband), I was asked to join Steve to provide veterinary supervision during elephant immobilization in the heart of the Ndoki forest.

As in the case of many good plans made in the office, ours went awry as soon as they met the realities of the forest. Instead of deploying all four collars, we spent a full month nomadically stalking through the Ndoki wilderness to shoot and collar just one elephant, a beautiful bull whom we called Sue (from the Johnny Cash song). In early 2001, we returned to the Ndoki to finish the job, but decided to go back to Dzanga National Park on the Central African Republic side of the border, where elephants are easier to find. This time we succeeded in collaring the three remaining elephants in just ten days.

The data from these four collared elephants have given us the first real window into the life of free-ranging elephants in central Africa. A former WCS scientist had successfully satellite-tagged forest elephants in Cameroon, but in those days the collar performance was poor and the elephants were in a forest surrounded by human activity. In the relative wilderness of Ndoki, our four collared elephants roamed over an area of about 2,300 square miles (nearly 6,000 square kilometers), with one individual using a home range measured at about 850 square miles (more than 2,200 square kilometers). The elephants

STEPHEN BLAKE

CONSERVATIONIST STEVE BLAKE REMOVES TICKS FROM AN IMMOBILIZED FOREST ELEPHANT AS PART OF A HEALTH ASSESSMENT.

BELOW: A MOTHER AND HER BABY GRAZE AT THE EDGE OF A FOREST IN GABON.

CARLTON WARD, JR.

could cross Nouabalé-Ndoki National Park rapidly, moving more than 37 miles (60 kilometers) in as little as three days, and traveling well into the neighboring logging concessions and unprotected areas. These data showed us what forest elephants can do in a vast, intact area of protected forest. But what about in areas around the park, where humans are modifying the landscape with roads, and where there is logging, poaching, and other hazards?

The purpose of the 2003 trip, to the buffer zone around Nouabalé-Ndoki National Park, was to begin to answer that question. The Ndoki National Park is one of the most remote areas in central Africa, and thanks to effective conservation management now enjoys almost no human activity other than research. However, surrounding the park, commercial logging, elephant poaching, and both commercial and subsistence hunting are increasing pressure on the elephants and their habitat.

VHF RADIOTRACKING SHOWED THAT A FEMALE ELEPHANT AND HER YOUNG CALF USED A HOME RANGE OF AT LEAST 340 SQUARE MILES (880 SQUARE KILOMETERS), CONSIDERABLY LARGER THAN MANY HAD SUSPECTED.

WHAT IS A FOREST ELEPHANT?

Why all the fuss about putting telemetry collars on forest elephants and learning about their movements? This question may best be answered by asking another. How many people even know that elephants exist in the depths of the central African forest?

At present, scientists recognize two species of living elephants: the Asian elephant (*Elephas maximus*) and the African elephant (*Loxodonta africana*). What most people don't realize is that the African elephant is further classified into two subspecies, the familiar savanna elephant, *L. africana africana*, and the mysterious forest elephant, *L. africana cyclotis*. Forest elephants are smaller than savanna elephants, they have straight, downward-pointing tusks, and their back is higher than their head, all of which are adaptations to life in dense forest. Recently, geneticists seem to be confirming what tropical forest ecologists had suspected for some time: Forest elephants may in fact be a distinct species.

Although there have been many studies, articles, books, and films about savanna elephants over the last several decades, the ecology of forest elephants, which in 1989 were thought to have made up more than one third of all Africa's elephants, has largely been ignored. These mega-herbivores, described by tropical ecologist Adrian Kortlandt as forest bulldozers, are true forest engineers, shaping the African rainforest through foraging, seed dispersal, and excavations for minerals, yet we know very little about them, including how to ensure their survival in the 21st century.

Studies conducted by forest-elephant specialists Richard Barnes, James "Buddy" Powell, Andrea Turkalo, and others have provided data on the abundance, distribution, foraging, and social structure of these elephants. Barnes and his team pioneered census techniques for elephants in central African forests, and in the late 1980s showed conclusively

that forest elephants had suffered enormous losses during the ivory trade boom years of the 1970s and 1980s. In a paper entitled "Man determines the distribution of elephants," published in the *African Journal of Ecology*, Barnes and his colleagues provided recommendations for conservation actions in the 1990s. In the first

CARLTON WARD, JR.

THREE FOREST ELEPHANTS CROSS A COASTAL LAGOON IN GABON.

comprehensive ecological study of forest elephants, James Powell showed the huge role forest elephants play in seed dispersal. Andrea Turkalo knows forest elephants as individuals and social beings better than anyone alive. Through tremendous dedication over more than a decade, Andrea now knows more than 2,800 individual elephants, and has helped ensure the protection of the Dzanga Bai in the Dzanga National Park, perhaps the most important single location for elephants on Earth. (Bais are water- and mineral-rich clearings probably created by elephants excavating for minerals. Our telemetry data show that bais may attract many hundreds of elephants from as far away as 62 miles, or 100 kilometers.)

More recently, Steve and his colleagues are

SHARON DEEM

ZOO VETERINARIAN SHARON DEEM (LEFT), WITH THE HELP OF MAMBELEME (RIGHT), ADMINISTERS A DRUG TO WAKE A BULL ELEPHANT AFTER HE'S BEEN COLLARED.

showing how elephants are true forest gardeners, planting the forest on an elephantine scale with more than 100 species of seeds, including many that are important foods for humans. His research shows that an elephant may eat a fruit in the heart of a national park, and a few days later deposit its seeds in a nutritious mass of dung 37 or more miles (60 or more kilometers) away in, for example, an unprotected logging concession. No other animal is able to shape the potential distribution of fruit trees in this way.

The ranging data we are amassing from the first five GPS-collared elephants are important for decision-making about land use and management. These data help demonstrate that even large national parks, with their finite boundaries, do not provide the space and resources necessary for the long-term survival of forest elephants. By adding more collared elephants to the study—elephants living in different habitats and under different land-use conditions both in and out of national parks—we will be able to see how roads, logging, hunting, and other human activities affect the movement of forest elephants and their ability to cope in a changing world. This information will help resource managers, governments, and industries to promote conservation on a scale sufficient to support the needs of viable elephant populations.

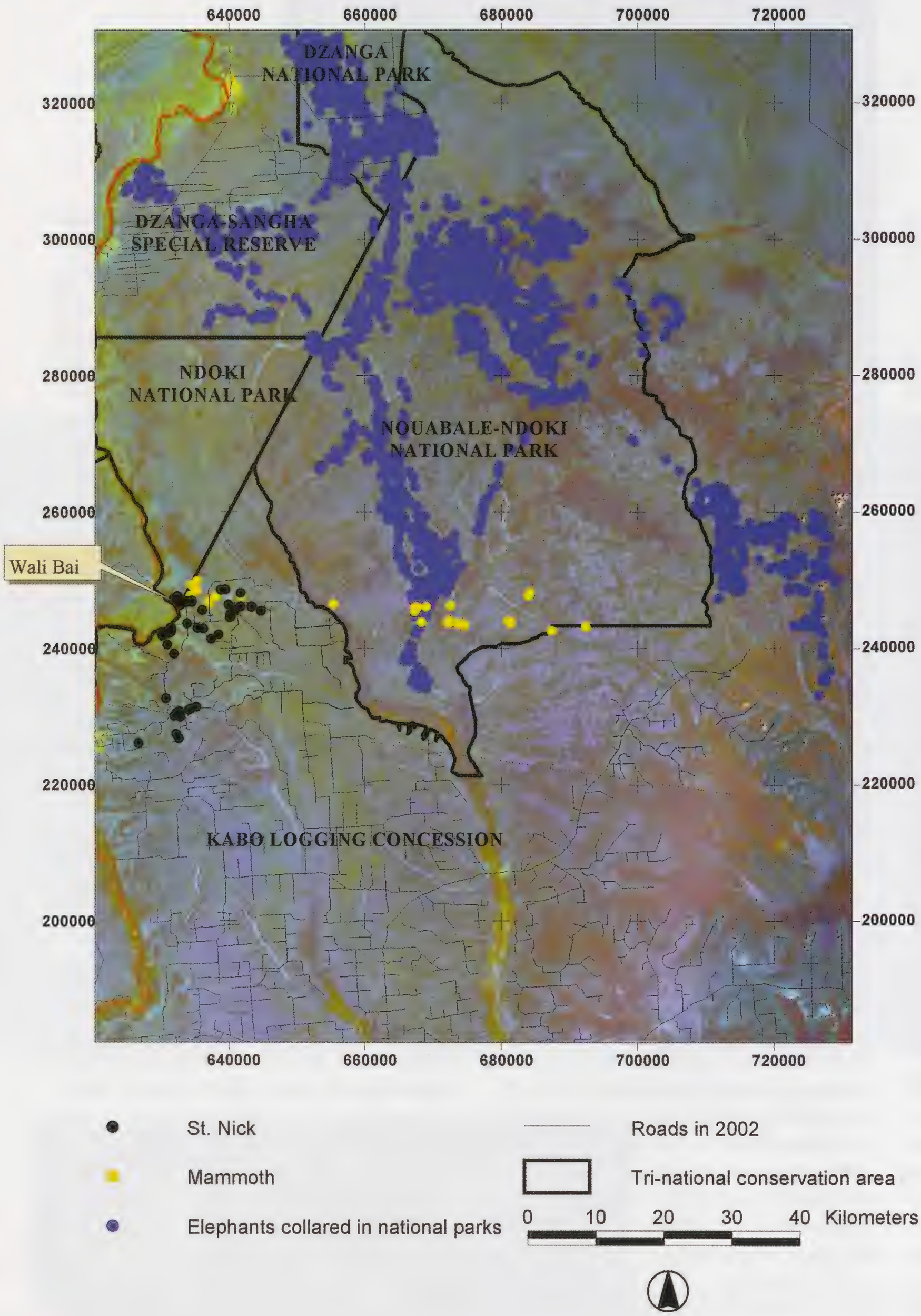
In the Ndoki, for example, the logging company *Congolaise Industrielle du Bois* is collaborating with WCS to improve forest management for the benefit of wildlife. Elephant-ranging data from this company's logging concession will certainly be incorporated into management planning.

Our study comes at a time when conservation, scientific, and commercial interests are all focusing on the nearly 772,00 square miles (two million square kilometers) of central Africa's forest as one of the richest biodiversity regions on the planet. This forest is home to elephants, forest buffalo, bongo antelope, leopards, golden cats, and more species of primates than anywhere else, including gorillas, common chimpanzees, and our closest relatives, bonobos. It supports many thousands of plant species, including an abundance of majestic hardwood trees that provide some of the most beautiful timber found anywhere on Earth.

Timber, and a wealth of commercially important minerals including gold and coltan that are important to the cell phone industry, make the Congo Basin's forest an essential economic resource, under present global

CARLTON WARD, JR.

THE STUDY MENTIONED IN THIS ARTICLE EVALUATES THE EFFECTS OF ROADS, LOGGING, AND POACHING ON FOREST ELEPHANTS.



THIS MAP SHOWS THE MOVEMENTS OF THE TWO BULL ELEPHANTS COLLARED IN 2003 AS COMPARED TO THE MOVEMENTS OF FOUR ELEPHANTS COLLARED IN THE DZANGA AND NOUABALE-NDOKI NATIONAL PARKS IN 2000 AND 2001.

economic conditions, for the development of the central African nations, some of which are among the poorest in Africa. In addition to rich flora and fauna, the Congo Basin is home to pygmies, possibly the oldest living human ethnic group. Pygmies, too, are in danger of disappearing due to the encroachment of commercial exploitation and increased human pressure from the exterior. Recent scientific studies on the biodiversity of the region, by organizations such as the Smithsonian National Zoo's Monitoring and Assessment of Biodiversity (MAB) Program, are now beginning to reveal the high level of biodiversity of this species-rich region (see "Teeming Life in Gabon's Rainforest," *ZooGoer* September/October 2003).

TRAVELS IN THE CONGO FOREST

During our 2003 trip, we camped for two weeks in various places within the forest surrounding Nouabalé-Ndoki National Park while we searched for elephants to safely immobilize and fit with telemetry collars. Unlike similar work on savanna elephants, in which the field team often drives to the elephants in air-conditioned Land Cruisers or flies in by helicopter, work in the forest is all on foot and a completely different undertaking. The first challenge is simply walking through the forest far enough to find areas with dense enough concentrations of elephants to have a reasonable chance of finding suitable individuals to collar.

Our team of local Bantu and pygmy people is essential for any mission into the forest. To walk in the forest for weeks on end, we must carry all the supplies we need for survival. These include food, tents, sleeping gear, and clothing to stay moderately comfortable in the wet, hot forest environment. We also have to haul the equipment for our veterinary and ecology studies. And even with the benefit of GPS "compasses," few Westerners have mastered the skills necessary to navigate in the thick forest. The pygmies know the forest like most of us know the streets of our hometowns, and they continually keep us on track. Importantly, some of the trackers have a deep and intimate knowledge of forest elephant behavior.

Two of the pygmy trackers with us, Mambeleme and Monyaka, have killed many elephants with handheld spears, and more recently with automatic weapons and large-caliber elephant guns, always at the behest of their Bantu "patron." For their services as elephant killers, pygmies may be paid with a new pair of shorts, a pot and pan, or a few dollars, and a beautiful pair

of tusks may be worth hundreds of dollars to the gun owner. But Mambeleme and Monyaka have

SHARON DEEM

THE DZANGA BAI IN DZANGA NATIONAL PARK ATTRACTS AN UNUSUALLY LARGE NUMBER OF FOREST ELEPHANTS.

now been working with Steve and WCS for many years and are glad to be off the poaching circuit, earning a steady salary, and involved in conservation efforts.

We relocated our camp four times to be near bais that appeared to be visited often by elephants. Some of our campsites were no more than tents pitched in the thick understory of the secondary-growth forest, which grows after primary forest has been selectively logged. When we found a site after a long day, the pygmies would quickly make a campfire and prepare a cooking area while we found flat areas in the thick bush to erect our tents before the light faded. Unfortunately, at many of these camps, the insects found us within an hour, making camp living less than pleasant. Other times, we stayed in research camps, where we enjoyed the luxury of sleeping on cots under wooden shelters.

We carried four collars with us, but the elephants were less abundant than we anticipated, and over the course of 13 days of hunting we had only two opportunities to dart one. In both instances, we successfully immobilized large bull elephants in the same bai, called Wali Bai, near the village of Bomassa, HQ of the Nouabalé-Ndoki National Park, fitted the telemetry collars, and collected samples for the health study.

Unusually high rainfall may have hampered our ability to find many elephants during this trip. Heavy rains dilute the minerals in bais, making them less attractive to elephants. The rain also increases the amount of fruit available in the forest, which tends to make the highly frugivorous forest elephants disperse in search of good food. The lack of elephants may also have been due to more human activity than we have previously encountered, which is, of course, the principal reason for the current study. Although most days would go by without our finding a hint of elephants nearby, we were fortunate to experience some of the forest's other inhabitants, including gorillas, chimpanzees, duikers, flying squirrels, and forest buffalo. The sights and sounds of the forest captivated us as we walked for miles in the forest or sat near a bai at dawn.

UNTIL NOW, ELEPHANTS HAVE BEEN THE PHANTOMS OF THE FOREST—THE TREES HAVE HIDDEN THEIR SECRETS FROM THE WORLD. UNFORTUNATELY, THE TREES ALSO HIDE THEIR MASSACRE.

It is always disappointing not to finish a job, but with two out of the four collars successfully deployed and no people or elephants hurt, we were satisfied. It is gratifying to know that two forest elephants are now wearing our collars and providing us with unique data about their daily movements. We are certainly fortunate to have an excuse to return to this enchanting forest to finish the job.

CARLTON WARD, JR.

A LONE FOREST ELEPHANT WADES CHEST-DEEP THROUGH A SEASONALLY FLOODED SWAMP.

We now have six months of data from the two collared bulls. You can see where these elephants have traveled during this period on the WCS-Congo and Save the Elephants websites (www.wcscongo.com, www.savetheelephants.com).

WHERE ARE THEY NOW?

Half a year has now passed since we deployed the collars on our two bulls. We are receiving a continuous update on one of the greatest mysteries left in the forest—the ranging patterns of elephants.

Surprisingly, the younger of the bulls, St. Nick, is rather sedentary, and concentrates his movements around the Wali Bai. He also appears to prefer the large openings caused by logging road junctions, which offer an abundant food supply of succulent ground vegetation. Unfortunately, he also frequents the plantations of the village of Bomassa—for St. Nick is a crop-raiding elephant. Crop-raiding often leads to human-elephant conflict, and it is a serious problem through the range

STEPHEN BLAKE

THIS LARGE BULL, NAMED SPARKEY, RETURNED TO THE EXACT SITE WHERE HE WAS COLLARED HOURS EARLIER. IMMOBILIZATION IS RARELY TRAUMATIC FOR FOREST ELEPHANTS.

of African elephants. But almost nothing is known of the underlying behavioral decisions made by crop-raiding forest elephants. We hope that these data will help us understand when, where, and why elephants such as St. Nick concentrate their crop-raiding activities, and enable us to predict and perhaps prevent them from crop-raiding in the future.

Old Mammoth, on the other hand, has not yet visited the Bomassa fields, but has instead traveled several times deep into the sanctuary of Nouabalé-Ndoki National Park. On each of his repeated visits to the park, he has taken roughly the same route, which he may have been using for more than 60 years. Unlike young St. Nick, Mammoth surely remembers when Bomassa village was the center of an intense poaching operation, and when the old habit of avoiding human beings at all costs was the only hope for a forest elephant's survival.

We expect these two collars to continue sending us data for two full years, which will show us the elephants' large-scale seasonal range and their smaller-scale movements and habitat use. Solving the mysteries of forest elephants is always both exciting and sad. Exciting, because with knowledge comes the power to reason and act intelligently; and sad, because with understanding, the mystery itself dies. Until now, elephants have been the phantoms of the forest—the trees have hidden their secrets from the world. Unfortunately, the trees also hide their massacre. We hope to use our knowledge to conserve the forest elephant and protect its habitat. If we succeed, perhaps the elephants will still keep a few secrets for themselves.

We thank the enormous and varied financial, logistical, technical, and political help provided by all of the collaborators involved in this work: the governments of Congo and Central African Republic, the Wildlife Conservation Society, the United States Agency for International Development, the U.S. Fish & Wildlife Service, the World Wildlife Fund, Save the Elephants, Lotek Engineering, and Telonics Inc. We also thank all our colleagues in Congo and Central African Republic for their tremendous support of this project.

—Sharon L. Deem is a veterinarian at the Smithsonian's National Zoo. Stephen Blake is the forest elephant conservation coordinator for the Wildlife Conservation Society. In Spring 2004, Sharon will return to central Africa as a member of a Smithsonian team of researchers working in the Gamba Complex of Gabon. On this future trip, Sharon plans to immobilize six forest elephants so that the team can place telemetry collars on them. Data collected from these elephants will help researchers better understand where forest elephants travel and how savanna corridors, which link forest patches in the region, are used by the elephants.

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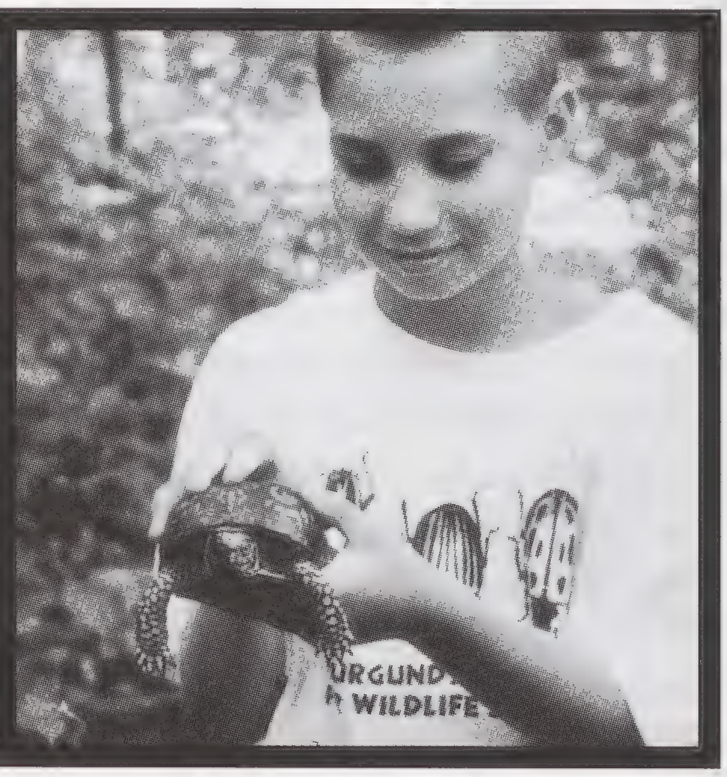


BOOKS, NATURALLY

"A significant part of the pleasure of eating is in one's accurate consciousness of the lives and the world from which the food comes."

—Wendell Berry

"In the hands of an able cook, fish can become an inexhaustible source of perpetual delight."

—Jean-Anthelme Brillat-Savarin

One Fish, Two Fish, Crawfish, Bluefish: The Smithsonian Sustainable Seafood Cookbook.
Carole C. Baldwin and Julie H. Mounts. 2003. Smithsonian Books, Washington, D.C. 330 pp., hardbound. $35.

Cookbook and conservation are words that rarely appear in the same sentence. But that may well change with the publication of this delicious volume that mixes gourmet recipes, scientific research, colorful illustrations, and seafood recommendations to serve up a uniquely appealing feast for the senses and the socially responsible soul.

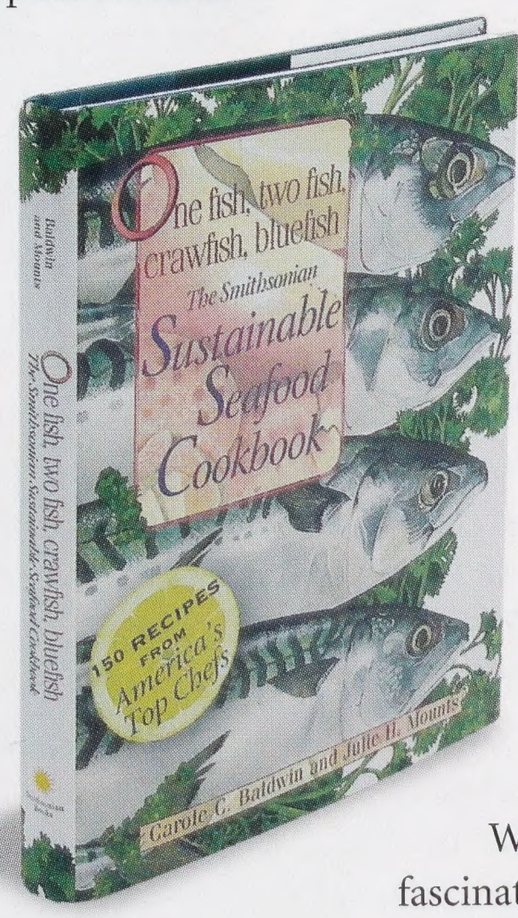
Carole C. Baldwin is a marine biologist at the Smithsonian's Museum of Natural History, and Julie H. Mounts a research assistant there. The text that surrounds the recipes in *One Fish, Two Fish, Crawfish, Bluefish: The Smithsonian Sustainable Seafood Cookbook* reflects their expertise in fish and their concern for the future of marine resources. Their focus is not on what seafood not to eat—any number of lists are available to tell consumers that—but on what seafood to eat, and how to prepare a variety of familiar and less familiar species, from salmon and tuna to eel and opah.

The premise of the book is upbeat: "We [the authors] believe the public can reap the benefits of a diet rich in seafood and at the same time support marine resource protection. . . .individuals can have a positive influence on conservation of marine resources simply by diversifying their seafood selections among well-managed stocks." Few conservation challenges are so amenable to such direct and painless action by the public, action that can really make a difference.

To provide the book's 150 seafood recipes, Baldwin and Mounts recruited contributions from 105 of the best chefs in the United States. These include such local luminaries as Roberto Donna of Galileo, Michel Richard of Citronelle, Bob Kinkead of Kinkead's, and Nora Pouillon of Restaurant Nora, as well as food celebrities such as Julia Child, Alice Waters, and Wolfgang Puck.

The book is organized into 20 chapters, each covering one or more types of shellfish or finfish. For instance, scallops and crabs merit a chapter each, while oysters, mussels, and clams are grouped in one chapter, catfish and tilapia in another. The number of recipes per chapter varies from 14 for the salmon, trout, and Arctic char group to two for herring and shad. Each chapter opens with an introduction to a species or group of species that describes their status in the wild or in aquaculture, how they are harvested to minimize ecological damage, their place in cuisine, and in a healthy diet.

The authors carefully explain the sometimes confusing rules for selecting seafood. Farmed Atlantic salmon should be avoided in favor of wild Alaskan salmon. Farmed rainbow trout and catfish are good choices, however, as are farmed mussels, which is a better choice than wild mussels. They explain that you have to be careful of misleading labeling: Line-caught may conjure up an image of a solitary fisherman with a rod and reel, but this label is also used for fish harvested by longliners, ". . .which lay thousands of baited hooks on or within miles of ocean, [and] frequently catch sea birds, sharks, and sea turtles. . .". On the other hand, diver scallops truly are handpicked by divers, while most other, non-farmed scallops are caught by dredging, which destroys marine habitats.



The recipes are clearly written, with careful instructions, planning and cooking tips, wine suggestions, and more. Suffice it to say, all sound delicious—and the ones I've tried have been. Grilled calamari with warm white-bean salad is a standout, and easy to prepare. More complicated but worth the effort is salmon (wild Alaskan salmon, that is) braised in grape juice with whipped red potatoes and horseradish, an unlikely combination of flavors that proved wonderful. Caesar salad with spicy fried oysters is a fabulous first course. But even if you never prepare a single one, you'll likely enjoy leafing through this book, because it includes much more than inspiring recipes.

In each chapter there is a sidebar called "In the Wild," offering an interesting bit of natural history on the animals. (Did you know that during warmer periods in the Pacific sardines dominate the waters, while anchovies prevail during cool periods, alternating in 25-year cycles?) A box in each chapter details scientific and common names, U.S. distribution, season, what to look and smell for when selecting, color, taste, and texture, and cooking methods. All of this helps in selecting and preparing seafood, whether you follow the recipes or not. The back of the book includes an article on U.S. seafood conservation issues, as well as sources for seafood in the book's recipes, a culinary glossary, and references and websites for more information.

Whether you're interested in great food, fascinating fish stories, or saving the planet—or all three—*One Fish, Two Fish, Crawfish, Bluefish* should be on your bookshelf. I think Wendell Berry and Jean-Anthelme Brillat-Savarin would agree.

—*Susan Lumpkin*

Please visit the related Smithsonian website at www.mnh.si.edu/seafood for more information.

BIO ALMANAC

The U.S. Fish & Wildlife Service may down-list American crocodiles (*Crocodylus acutus*) from endangered to a threatened status. Thanks to recovery efforts, the U.S. American crocodile population rebounded from a low of 400 individuals 30 years ago to almost 1,000 individuals today.

American crocodiles were officially declared endangered in 1975, when their numbers declined rapidly due to habitat loss and hunting. Increasing development in Florida in the 1970s and '80s encroached on coastal estuaries—key croc habitat—where mangrove swamps protected crocs from wind and waves, and fresh water from the Everglades mixed with the salt water of Florida Bay to protect salt-sensitive hatchlings. The hunting and exploitation of the crocs for their skins, which can be tanned and made into leather accessories, also accelerated their decline.

The most crucial elements in the crocs' recovery have been hunting restrictions and the cleanup of imperiled Everglades estuaries. The 1994 Everglades Forever Act created Stormwater Treatment Areas (STAs) that filter nutrients out of water flowing into the Everglades, improving water quality and directing an influx of clean, fresh water into Florida Bay. The crocs aren't the only ones to benefit—University of Florida scientists believe that the crocs' comeback indicates an overall improvement in the health of the Everglades.

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AMERICAN CROCODILE.

Re-establishment of croc populations will likely increase the frequency of encounters between humans and crocodiles. Fear of American crocs may be misdirected, however; they're not the same formidable predators as their larger Nile (*Crocodylus niloticus*) and Australian (*Crocodylus porosus*) cousins.

—*Kit Sergeant*

The North Pacific's ecosystem remains in flux half a century after Japanese and Russian whaling ships conducted massive whaling campaigns in its waters, a new study reveals. Slaughter of great whales, including bowhead, sperm, and humpback whales, caused irreversible damage down the food chain that is currently affecting fragile kelp forests in Alaska's Aleutian Islands.

Puzzled by a 90 percent reduction of kelp forests in some areas, scientists concluded that a population explosion of kelp-grazing sea urchins (genus *Strongylocentrotus*) was to blame. The sea urchins were proliferating because one of their main predators, sea otters, had become scarce in the 1990s. The scientists were able to trace the cause of the otters' disappearance up the food chain, through a string of events that began 50 years ago with the commercial whaling campaigns.

The whaling ships took half a million great whales, depriving orcas of their main prey. The orcas were forced to turn to alternative prey sources, beginning with harbor and fur seals. It takes a lot of seals to equal the caloric value of a single whale; consequently, the orcas soon depleted seal stocks, and moved on to sea lions, with similar results. When most of their larger prey populations were exhausted in the 1970s and '80s, orcas began to hunt the relatively diminutive sea otter, causing a population crash for the otters that began in the 1990s and a subsequent sea urchin boom. This domino effect reinforces the need for ecosystem-scale conservation, rather than species-specific conservation.

—*Kit Sergeant*

MASA USHIODA

NURSE SHARK.

WHAT'S IN A NAME

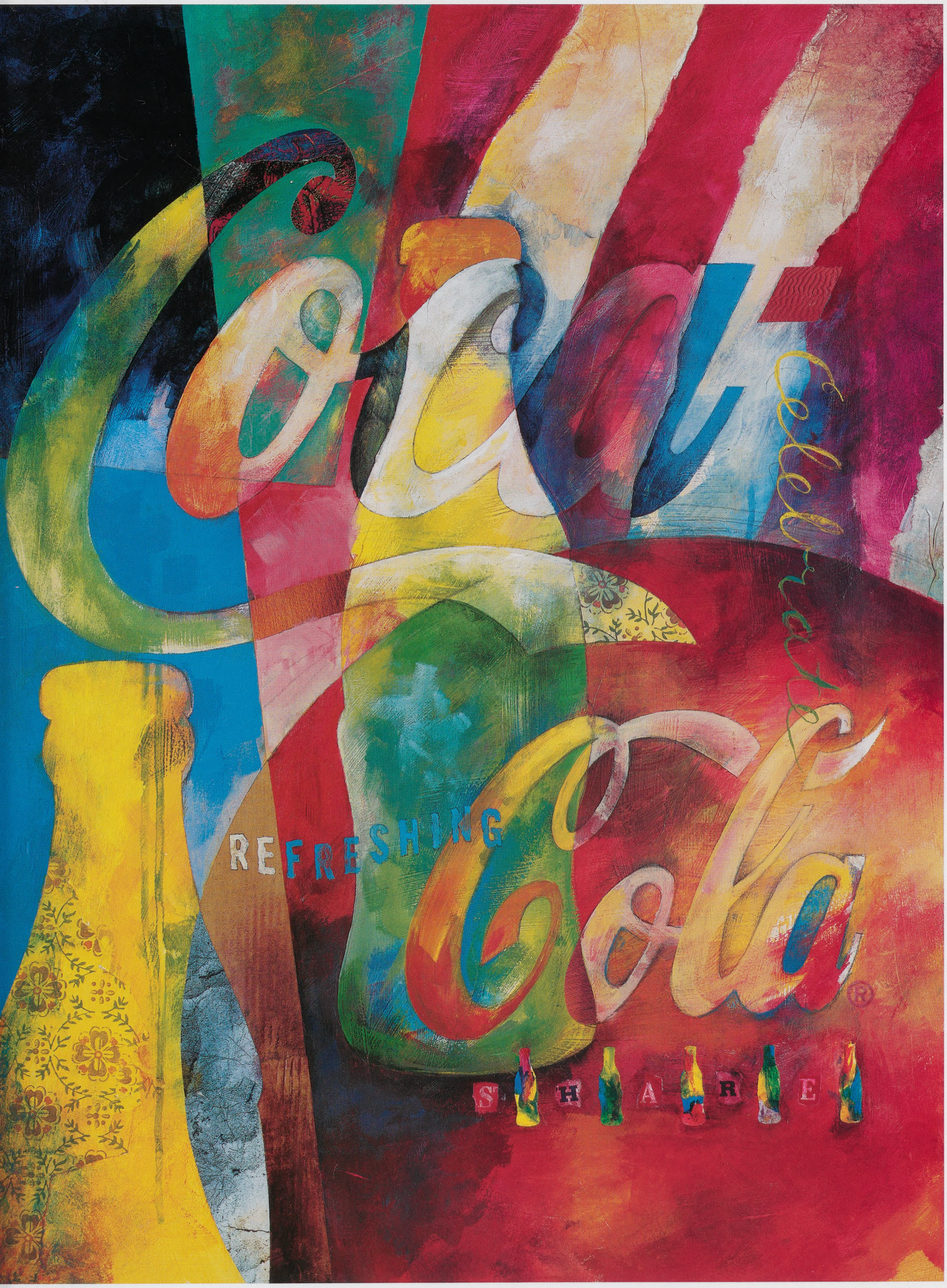
Contrary to what the name might lead you to believe, nurse sharks (*Ginglymostoma cirratum*) do not suckle their young. They do not heal ailing sea creatures, nor do they accompany doctor fish on reef rounds. In fact, as a prominent Gulf of Mexico and Caribbean reef predator, the nurse shark is more marauder than nurturer.

Some attribute the origin of the nurse shark's name to the sounds it makes when it feeds. A bellow-like pharynx rapidly expands the shark's gill and mouth cavities, creating a powerful suction that siphons shellfish prey from between rock crevices. The noise made from this vacuum-like noshing is likened to that of a nursing baby.

It's more likely that the common name was derived from the Old English term for a seafloor shark. Smaller sharks common to the British Isles were termed *huss*, *husse*, or *hurse*. In medieval England, the "n" from *an* was often transferred to the next word if it began with a vowel. Hence, *an hurse* became *a nurse*. Early English settlers probably named the bottom-dwelling New World shark after those familiar to them in England.

The truest description of the shark lies in its scientific name. *Ginglymostoma* is derived from the Greek words *gynglimos*, meaning "hinge" and *stoma*, meaning "mouth." The species name *cirratum* is from the Latin word for curl. Thus, "the shark with the hinged, curly mouth" most accurately portrays this noteworthy fish.

—*Kit Sergeant*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